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(54) Film instability compensation system.

(57) To compensate for the effects of film instability in a film gate, a film instability compensation system comprises a positional transducer (2) for measuring the position of the film edge relative to a sprocket hole (4) which is maintained in contact with a sprocket tooth (6) by pressure roller (8). Positional tranducer (2) measures the distance between the film edge and a sprocket hole and then measures deviations from the distance for subsequent sprocket holes to form a compensation signal. The output of the positional transducer (2) is coupled to a delay unit (10) which delays the signal corresponding to the error at a particular sprocket hole until that sprocket hole reaches the film gate.

Signals representative of the cyclic errors incurred due to the relative lateral displacement of the sprocket holes, are stored in the memory 30 and are applied to a subtractor circuit 24, within which the compensation signal from the output of the pipeline register 22 is adjusted to take account of the cyclic errors, and to provide an overall compensation signal which is applied to the horizontal scan shift when the appropriate sprocket hole reaches the film gate.

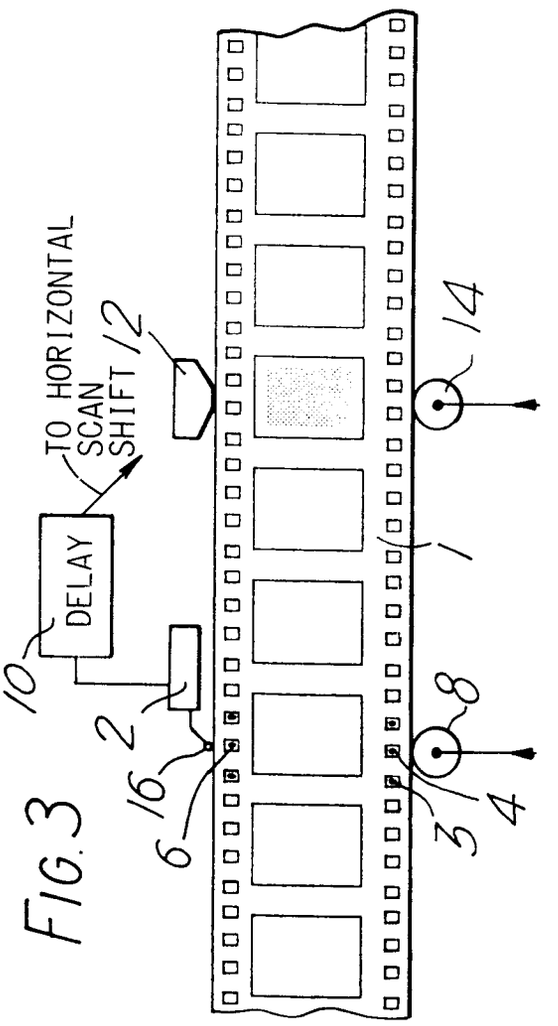

FIG. 3

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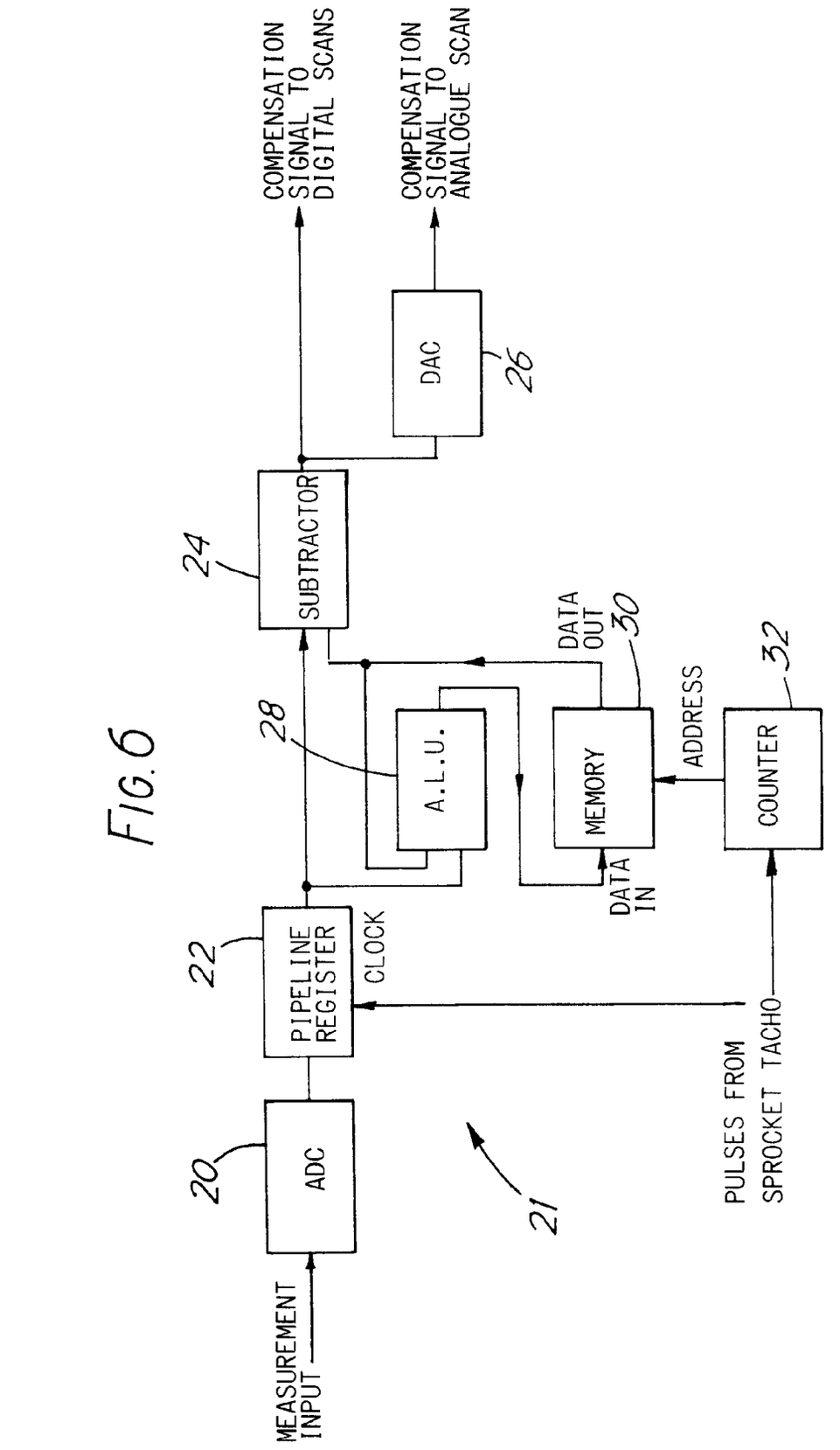
FIG.6


MEASUREMENT INPUT
ADC
20
PIPELINE REGISTER
22
CLOCK
SUBTRACTOR
24
COMPENSATION SIGNAL TO DIGITAL SCANS
DAC
26
COMPENSATION SIGNAL TO ANALOGUE SCAN
A.L.U.
28
MEMORY
DATA OUT
30
DATA IN
ADDRESS
COUNTER
32
PULSES FROM SPROCKET TACHO
21

This invention relates to methods and apparatus for compensating for positional instability of film passing through a film gate in a telecine or film writer.

The picture frames on cinematographic film are conventionally registered with the sprocket holes by means of register pins. A steady picture-display is ensured in such systems as film projection equipment can display each frame using a similar registration mechanism. However, in telecine and film writers for example, the film conventionally moves through the film gate at a steady speed and thus register pins cannot be inserted.

In conventional telecine equipment, the cinematographic film is positioned in the film gate by pressing one edge against the guide skid as illustrated schematically in Figure 1 and 2. As the picture frames are located relative to the sprocket holes and not the film edge, a problem arises when the edge of the film is uneven and not accurately related to the sprocket holes. In such an instance, the frame with the picture image will wander in sympathy with the irregularities in the film edge.

The CRT beam scans the same area of the film gate for each frame, thus if the frame is slightly misplaced on the film its actual position will not coincide exactly with the CRT scan. This will have the result that the displayed image will weave slightly from side-to-side. Because film manufacturers register picture frames with respect to sprocket holes little care is taken over the taughtness of the film edge, heightening film weave.

It is desirable to minimise this film instability effect, and various methods for so doing have been proposed, US patent number 4104680 for example, teaches moving the CRT scan to compensate for the film motion and the error is measured by optical detection of the sprocket hole.

A disadvantage of such a system is that further errors may ensue due to the presence of dirt or dust in the sprocket hole.

According to the present invention there is provided apparatus for compensating for film instability in a film gate of an apparatus for converting between images recorded on film and video signals, the converting apparatus having flying spot scanner means for scanning with a flying spot the images recorded on film at a scanning location as the film moves past the scanning location, and means for generating a scan pattern for the flying spot, the compensating apparatus comprising means for determining the position of a sprocket hole with respect to the film edge, means for deriving a compensation signal based on the determined position of the sprocket hole, means for applying the compensation signal to shift the position of the scanning beam of a flying spot scanner at a scanning location as the film moves past the scanning location, wherein the means for deriving a compensation signal comprises means for measuring the distance between the film edge and a first sprocket hole at a position prior to the scanning location in the direction of movement of the film, means for measuring deviations from the said measured distance in subsequent measurements of distances between the film edge and following sprocket holes, and means for deriving a compensation signal from the measured deviations.

A system embodying the invention may have a number of advantages. Most notably, the problems incurred in optical sensing techniques due to the presence of dust or dirt in the sprocket holes or damaged sprocket holes are overcome as the film is registered against the teeth of a sprocket wheel, this being analogous to the register pins in a conventional cine projector, and the position of the film edge is measured at this point relative to the sprocket teeth. Preferably the distance is measured using a stylus applied to the film edge.

The invention also provides a method of compensating for film instability in an apparatus for converting between images recorded on film and images represented by video signals, the converting apparatus comprising flying spot scanner means for scanning with a flying spot the images recorded on film at a scanning location as the film moves past the scanning location, and scan generation means for generating a scan pattern for the flying spot, characterised in that the method comprises measuring the distance between the film edge and a first sprocket hole on the film at a position prior to the scanning location in the direction of movement of the film, measuring the said distance at the said position for a second and subsequent sprocket holes, measuring deviations from the said distance measured at the first sprocket hole and at second and subsequent sprocket holes, deriving a compensation signal from the said measured deviations, and applying the compensation signal to the scan generation means of the flying spot scanner.

In a preferred embodiment the means for applying the compensation signal comprises means for delaying application of the compensation signal to the scan generation means of the flying spot scanner, until a sprocket hole on the film at which the compensation signal is determined arrives at the scanning location of the scan generation means. Preferably the means for applying the compensation signal comprises means for deriving a cyclic error compensation signal to compensate for cyclic errors due to relative lateral displacement of the sprocket holes on the sprocket teeth. It is advantageous to determine the cyclic errors attributable to the sprocket teeth and which repeat as the sprocket wheel rotates. These errors can be subtracted from the derived compensation signal to give a more accurate indication of the error due to film weave alone.

Embodiments of the invention will now be described by way of example, and with reference to the ac-

companying drawings, in which:

Figure 1 is a conventional guidance system showing a film as it passes through a telecine film gate;

Figure 2 is an enlarged view of a portion of the conventional guidance system of Figure 1;

Figure 3 is a schematic diagram of a guidance system embodying the invention;

Figure 4 is an enlarged view of a portion of the system of Figure 3;

Figure 5 is a block diagram of the compensation circuit including the delay means shown in Figure 4; and

Figure 6 is a block diagram of a further development of the compensation circuit of Figure 5.

The guidance system in Figures 3 and 4 for a flying spot scanner (not shown) shows film 1 passing over a sprocket wheel, the teeth 6 of which locate in the sprocket holes 3 of the film. The flying spot scanner scans frames and film as they pass through a film gate 11 to convert between images recorded on film and video signals. A first pressure roller 8 ensures that the film is located pressing against the inside edge of the sprocket teeth 6 on the side of the film adjacent to a positional transducer 2. This may be seen from the enlarged view of the system shown in Figure 4. A stylus 16 of the positional transducer device 2 bears on the film edge at a position prior to the scanning location 11 in the direction of movement of the film, and acts to measure the distance between the film edge and a first sprocket hole 4, and deviations therein for subsequent sprocket holes, to provide signals representative of the positional errors at the sprocket holes. The output of the positional transducer system 2 is coupled to a delay unit 10 which delays the signal corresponding to the error of a particular sprocket hole until that sprocket hole reaches the film gate, at which point it is applied as a compensation signal to shift the horizontal position of the scanning beam of the flying spot. The film passes through the film gate 11 where it is scanned by the CRT raster. The film is maintained in position laterally at this point, by a second pressure roller 14 which presses the film edge against a guide skid 12.

The output from the positional transducer shown in Figures 3 and 4 is digitised by a/d converter 20 as shown in Figure 5. The digitised signal is then applied to a pipeline register 22. This error signal is clocked through the pipeline register by pulses obtained from the rotation of the sprocket wheel due to movement of the film, so that the compensation signal corresponding to a particular sprocket hole is delayed and arrives at the output of the register at the same time as that sprocket hole arrives at the scanning area. The signal is then either applied directly to the scan shift to compensate a digital scanning system, or converted to an analogue signal in a d/a converter 26 and applied to compensate for horizontal weave of the film image.

A second embodiment is shown in Figure 6. This circuit derives a further compensation signal which compensates for cyclic errors due, for example, to imperfections in the sprocket wheel such as the relative lateral displacement of the sprocket teeth.

A proportion of the output of the pipeline register 22 is added in an arithmetic logic unit 28 to a proportion of the value stored in a memory 30 corresponding to previous outputs relating to particular sprocket teeth. As the film runs, so the ALU 28 will build up stored values in the memory 30 corresponding to the errors in the location of the teeth in the sprocket wheel. The memory locations are addressed by the counter 32 which is advanced or retarded by pulses from the sprocket tachometer according to the direction of film motion, each address corresponding to one sprocket tooth. The output from the memory 30 provides signals representative of the cyclic errors and is applied to a subtractor circuit 24, which subtracts the output from memory 30 from the compensation signal from the output of the pipeline register 22 to take account of the cyclic errors, so providing an overall compensation signal.

Various alternatives to the embodiments described are possible and will occur to those skilled in the art. For example, although the system embodying the invention has been described with reference to a flying spot telecine, it would be possible for the invention to be included in a flying spot film writer system. Also, the stored signals representative of the cyclic errors present may be precalibrated or automatically entered by taking the long term average of measure$ for each tooth.

In some cases, it may be advantageous for the output of the pipeline register to be sampled at a faster rate than once per sprocket tooth as described. This may be achieved by providing more pulses from the sprocket tachometer.

The positional transducer may be a record player type stylus and a piezo-electric transducer mechanically modified to fit the telecine viewing gate.

Claims

1. Apparatus for compensating for film instability in a film gate of an apparatus for converting between images recorded on film and video signals, the converting apparatus having flying spot scanner means for scanning with a flying spot the images recorded on film at a scanning location as the film moves past the scanning location, and means for generating a scan pattern for the flying spot, the compensating apparatus comprising means (2,16) for determining the position of a sprocket hole with respect to the film edge, means (20,22;21) for deriving a compensation

signal based on the determined position of the sprocket hole, means for applying the compensation signal to shift the position of the scanning beam of a flying spot scanner at a scanning location as the film moves past the scanning location, characterized in that the means for deriving a compensation signal comprises means (2,16) for measuring the distance between the film edge and a first sprocket hole at a position prior to the scanning location in the direction of movement of the film, means (2,16) for measuring deviations from the said measured distance in subsequent measurements of distances between the film edge and following sprocket holes, and means for deriving a compensation signal from the measured deviations.

2. Apparatus according to Claim 1, wherein the distance measuring means (2,16) is arranged to bear on the edge of the film (1).

3. Apparatus according to Claim 2, wherein the distance measuring means (2,16) comprises a positional transducer (2).

4. Apparatus according to Claim 3, wherein the positional transducer (2) comprises a stylus (16), and a piezo-electric transducer.

5. Apparatus according to any preceding claim comprising a sprocket wheel with a plurality of sprocket teeth (3;6), and a pressure roller (8) for bearing on the film edge to urge the edges of the sprocket holes (4) against the sprocket teeth (3;6).

6. Apparatus according to any preceding claim, wherein the means for applying the compensation signal comprises means (10;22) for delaying application of the compensation signal to the scan generation means of the flying spot scanner, until a sprocket hole on the film (1) at which the compensation signal is determined arrives at the scanning location of the scan generation means.

7. Apparatus according to any preceding claim, wherein the means for applying the compensation signal comprises means (21) for deriving a cyclic error compensation signal to compensate for cyclic errors due to relative lateral displacement of the sprocket holes (4) on the sprocket teeth (3;6).

8. Apparatus according to Claim 7, wherein the means (21) for deriving the cyclic error compensation signal comprises memory means (30) for storing signals indicative of the cyclic errors for a first and subsequent sprocket teeth, wherein the means for deriving the overall compensation signal comprises means (24) for subtracting the stored cyclic error signal for successive sprocket teeth from the compensation signals derived for successive sprocket holes, and timing means (32) for synchronising the arrival of the stored cyclic error signals and the compensation signals at the subtracting means (24).

9. A method of compensating for film instability in an apparatus for converting between images recorded on film and images represented by video signals, the converting apparatus comprising flying spot scanner means for scanning with a flying spot the images recorded on film at a scanning location as the film moves past the scanning location, and scan generation means for generating a scan pattern for the flying spot, characterised in that the method comprises measuring the distance between the film edge and a first sprocket hole on the film at a position prior to the scanning location in the direction of movement of the film, measuring the said distance at the said position for a second and subsequent sprocket holes, measuring deviations from the said distance measured at the first sprocket hole and at second and subsequent sprocket holes, deriving a compensation signal from the said measured deviations, and applying the compensation signal to the scan generation means of the flying spot scanner.

FIG. 1 (PRIOR ART)

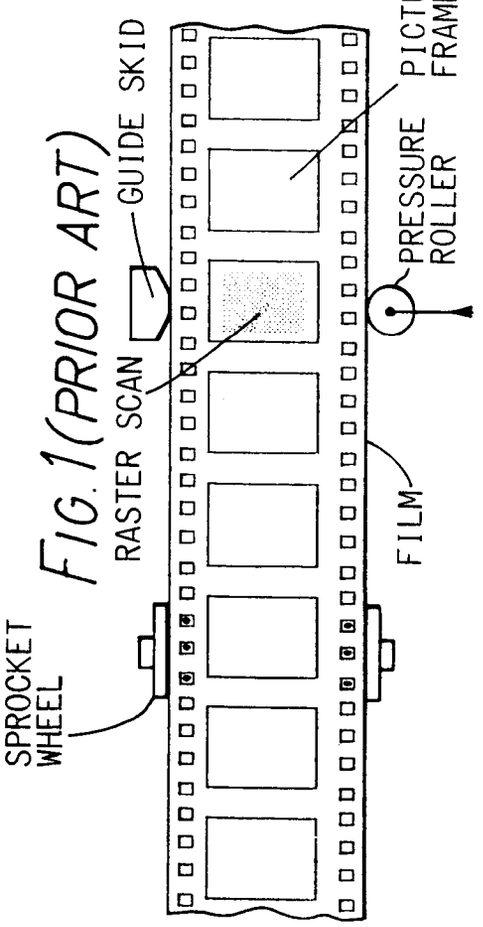


FIG. 2 (PRIOR ART)

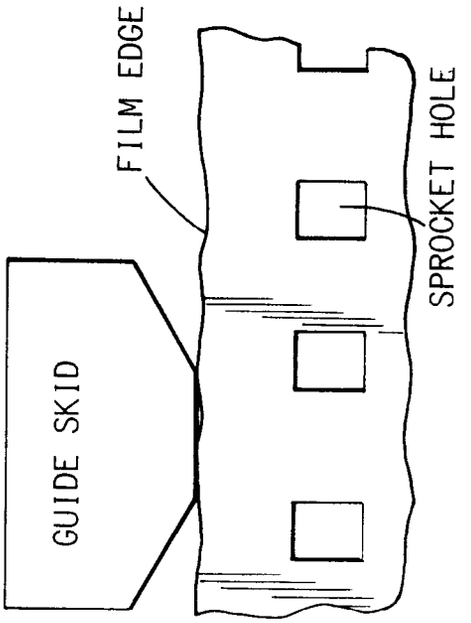


FIG. 3

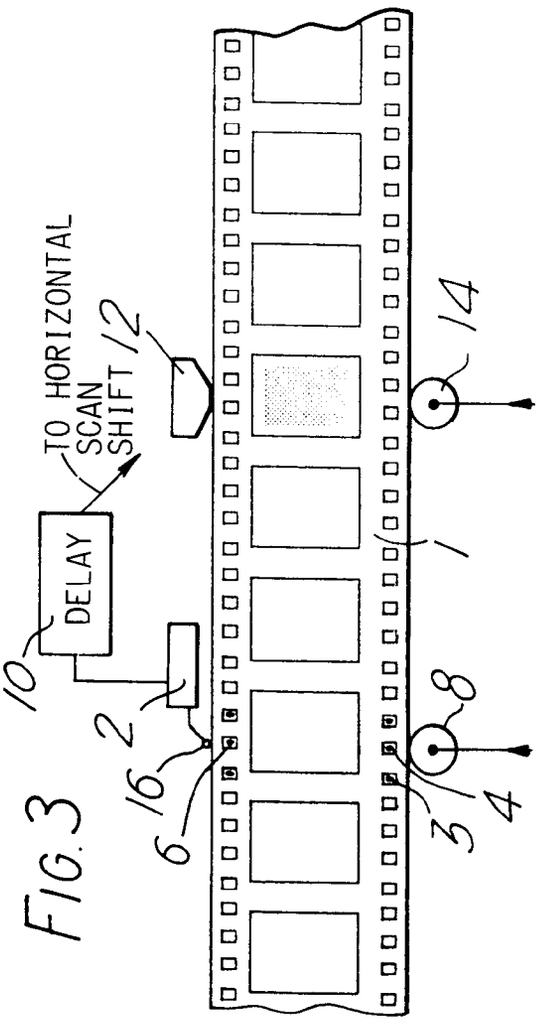


FIG. 4

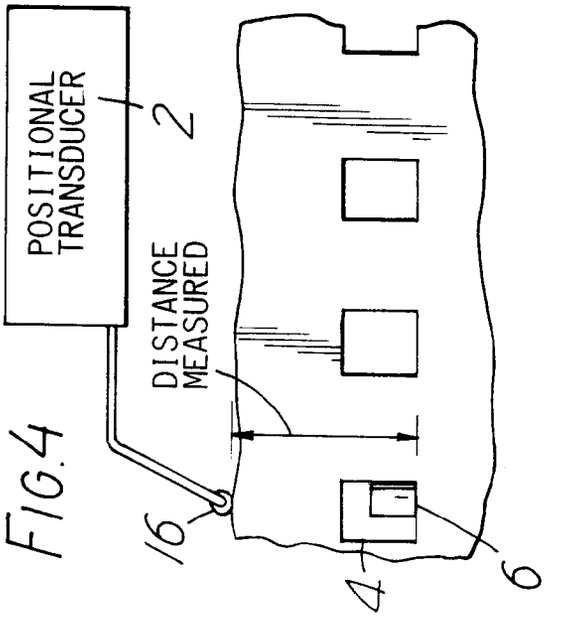


FIG.5

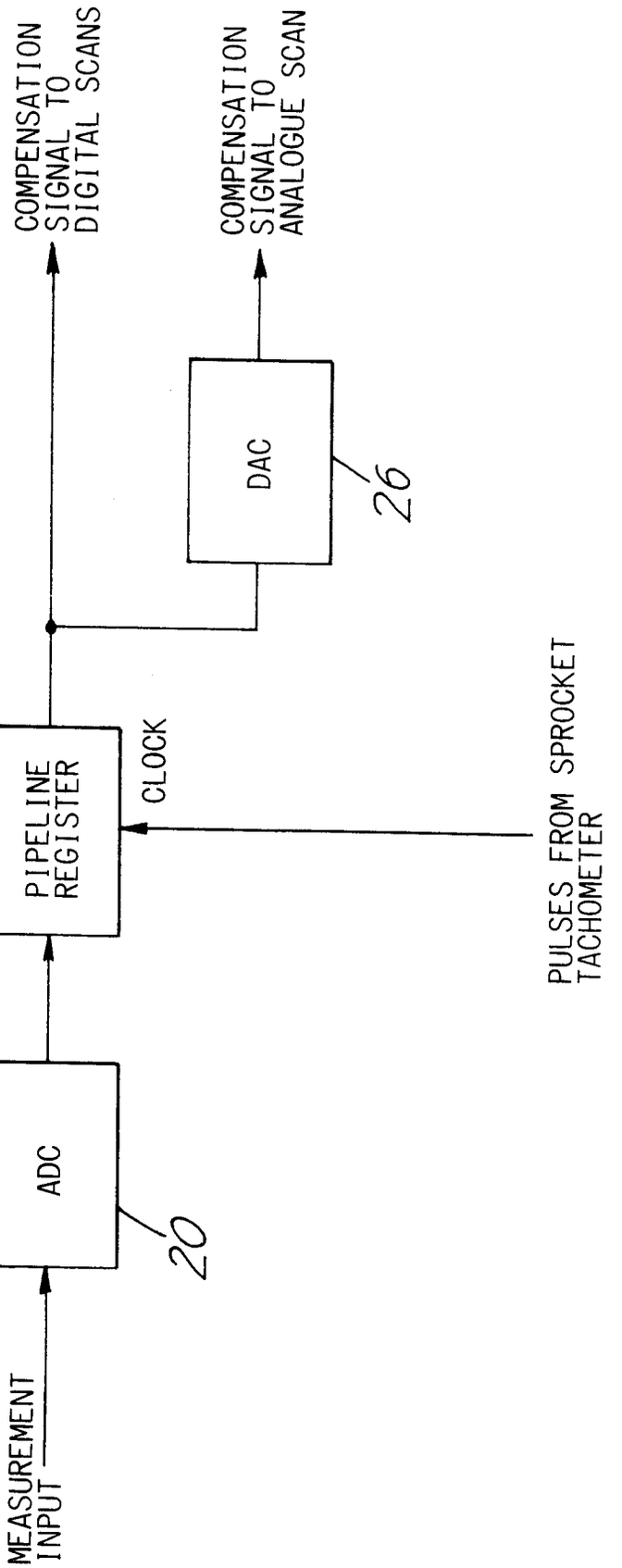
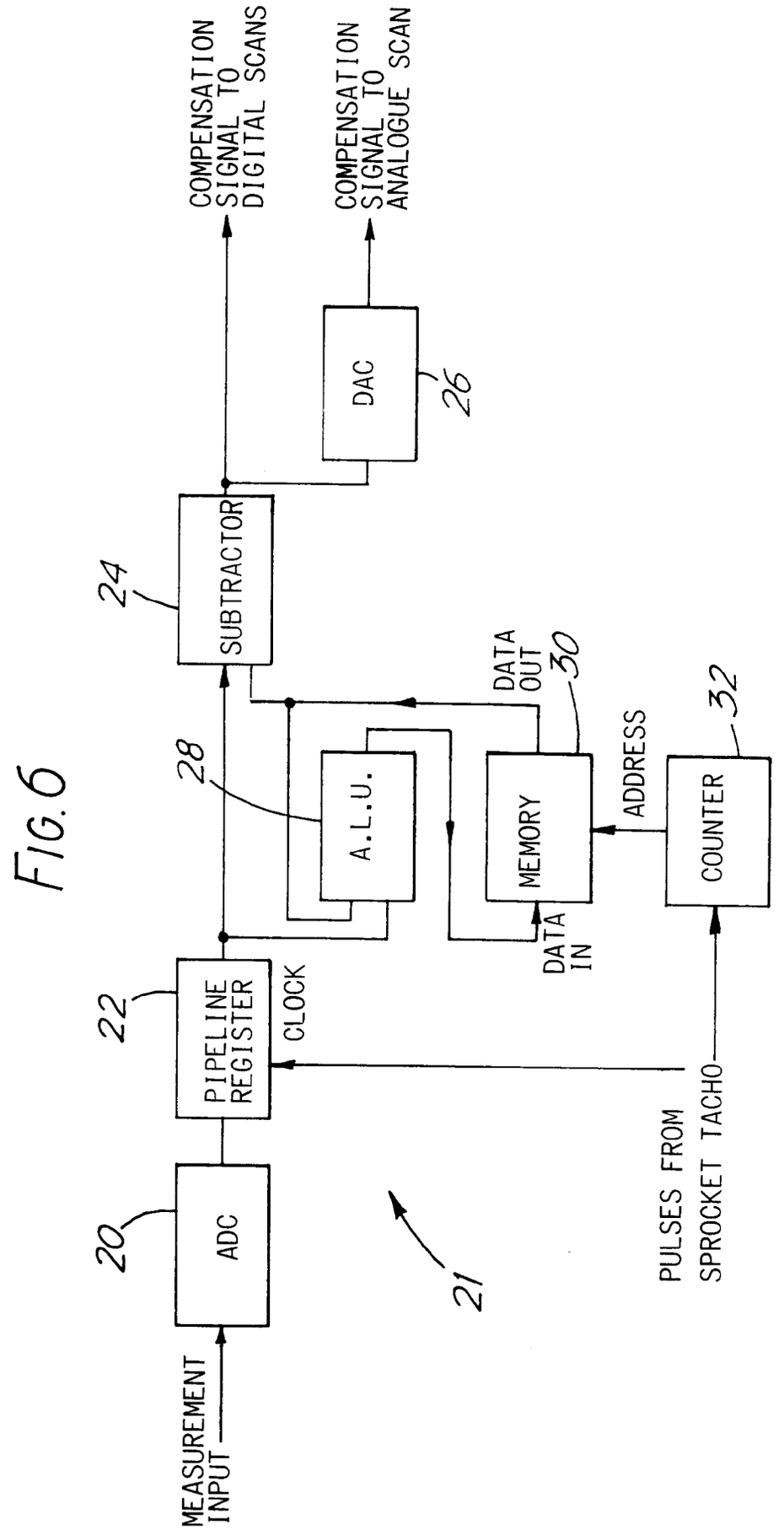

COMPENSATION SIGNAL TO DIGITAL SCANS
COMPENSATION SIGNAL TO ANALOGUE SCAN
DAC
26
22
PIPELINE REGISTER
CLOCK
PULSES FROM SPROCKET TACHOMETER
ADC
20
MEASUREMENT INPUT

FIG. 6


MEASUREMENT INPUT
ADC
20
PIPELINE REGISTER
22
CLOCK
SUBTRACTOR
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COMPENSATION SIGNAL TO DIGITAL SCANS
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26
COMPENSATION SIGNAL TO ANALOGUE SCAN
A.L.U.
28
MEMORY
30
DATA OUT
DATA IN
ADDRESS
COUNTER
32
PULSES FROM SPROCKET TACHO
21

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 31 0350

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 104 680 (HOLLAND) * column 2, line 5 - line 31 * * column 4, line 35 - line 41 *	1,6,9	H04N3/38 H04N5/257
A	US-A-3 650 448 (JARMY) * column 1, line 71 - column 2, line 5; figure 1 *	1-4,9	
A	WO-A-8 801 822 (ENCORE VIDEO INC) * abstract *	1,9	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

H04N

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	01 FEBRUARY 1993	BEQUET T.P.

CATEGORY OF CITED DOCUMENTS

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